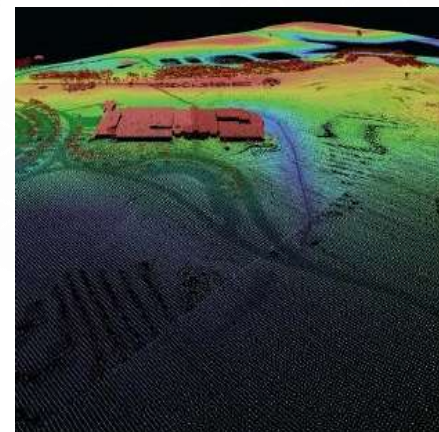
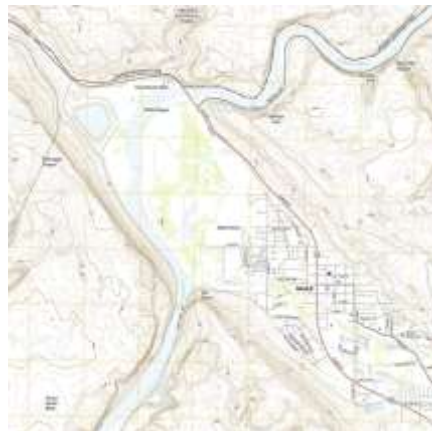




National Geospatial Program

Mapping in the 21st Century



Dr. Mike Tischler
Director
National Geospatial Program
United States Geological Survey

National Geospatial Advisory Committee
March 22, 2017

+ Mapping in the 21st Century

Decision Making

Federal Agencies exist to benefit society

The benefits to society of geospatial information result from the use of the information in decision making*

NGP helps the country make better decisions to...

Understand environmental variability

Save lives and property

Conserve resources



* - Bernknopf and Shapiro, 2015, "Economic Assessment of the Use Value of Geospatial Information",

+ Purpose of the NGP

3

Provides data to the public that is:

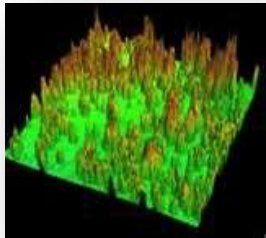
- **Authoritative** - data we can stand behind as the mandated federal agency
- **Accurate** - QA/QC, specs, and due-diligence to ensure the data is accurately representing the desired natural phenomena
- **Accessible** – Customers/clients are able to reach and properly leverage NGP data products
- **Available** - NGP produces the data our customers expect for their needs

NGP data and services:

- Advance the scientific understanding of our natural world
- Inform critical decisions within private sector, Federal government agencies, State and Local government, and Tribes

+ NGP Principle Program Areas

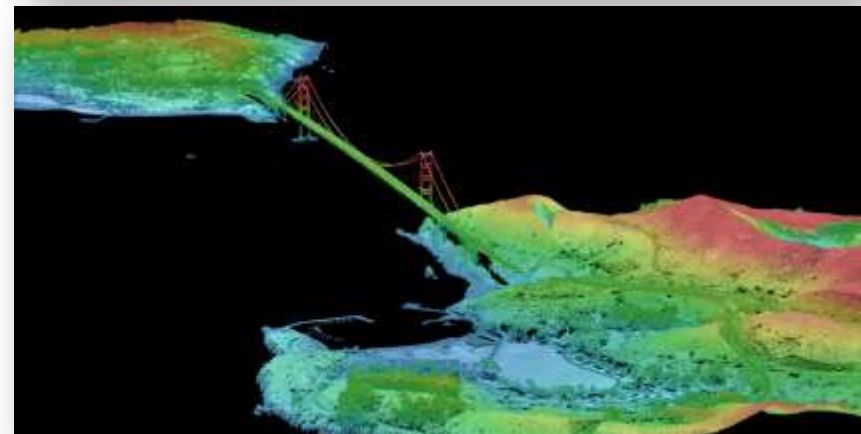
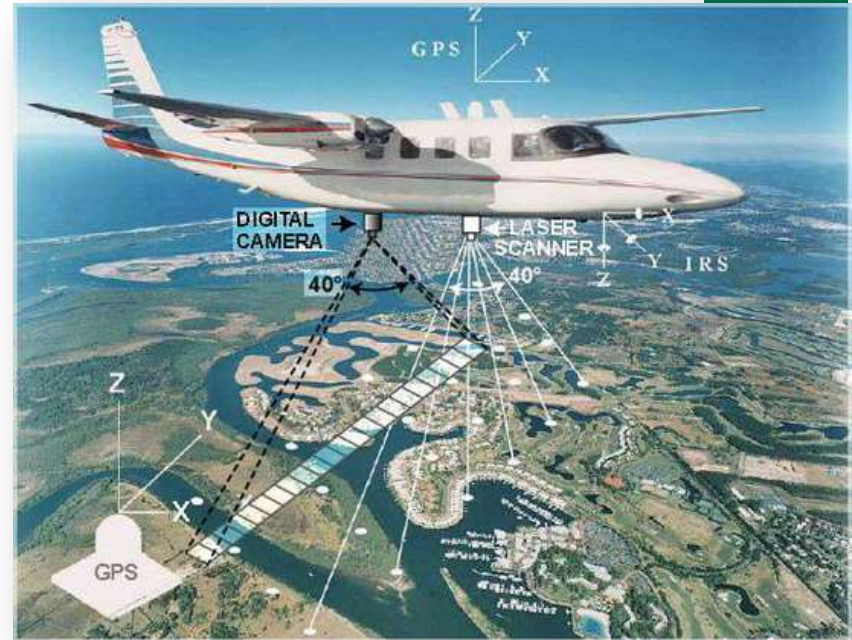
Geospatial products and services support key priorities



Area of National Leadership	Program Emphasis
A-16 Lead for Terrestrial Elevation	3D Elevation Program (3DEP)
A-16 Co-Lead for Inland Waters	National Hydrography and Watershed Boundaries Datasets, NHD+HR and Open Water Data Initiative
Nationwide Topographic Maps	U.S. Topo and Alaska Mapping

+ 3D Elevation Program (3DEP)

- Apply lidar technology to map bare earth and 3D data of natural and constructed features; increase the quality level of lidar being acquired to enable more accurate understanding, modeling, and prediction
- Goal to complete acquisition of national lidar coverage with IfSAR in Alaska in 8 years
- Address the mission-critical requirements of 34 Federal agencies, 50 states, and other organizations documented in the National Enhanced Elevation Assessment
- ROI 5:1, conservative benefits of \$690 million/year with potential to generate \$13 billion/year
- Leverage the capability and capacity of private industry mapping firms
- Achieve a 25% cost efficiency gain by collecting data in larger projects
- Completely refresh national elevation data holdings with new products and services



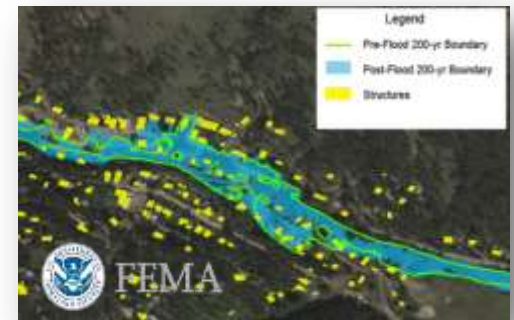
+ 3D Elevation Program

Mission Critical Applications

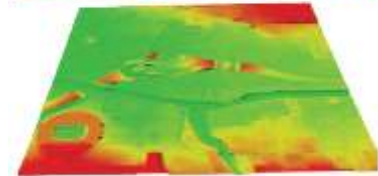
Rank	Business Use	Annual Benefits	
		Conservative	Potential
1	Flood Risk Management	\$295M	\$502M
2	Infrastructure and Construction Management	\$206M	\$942M
3	Natural Resources Conservation	\$159M	\$335M
4	Agriculture and Precision Farming	\$122M	\$2,011M
5	Water Supply and Quality	\$85M	\$156M
6	Wildfire Management, Planning and Response	\$76M	\$159M
7	Geologic Resource Assessment and Hazard Mitigation	\$52M	\$1,067M
8	Forest Resources Management	\$44M	\$62M
9	River and Stream Resource Management	\$38M	\$87M
10	Aviation Navigation and Safety	\$35M	\$56M
:			
20	Land Navigation and Safety	\$0.2M	\$7,125M
Total for all Business Uses (1 – 27)		\$1.2B	\$13B

NEEA Refresh is underway in partnership with NOAA

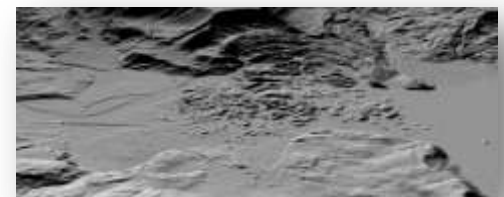
- Improve documentation of requirements and benefits based on what users know and need today
- Plan for next cycle after national coverage is achieved – what repeat rate and QLs are needed?



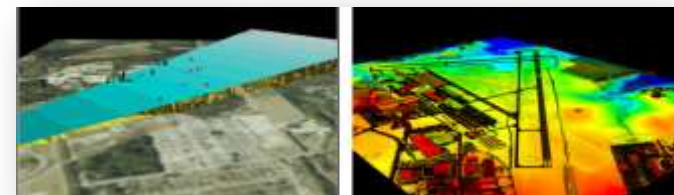
Flood Risk Management



Infrastructure



Geologic Hazards



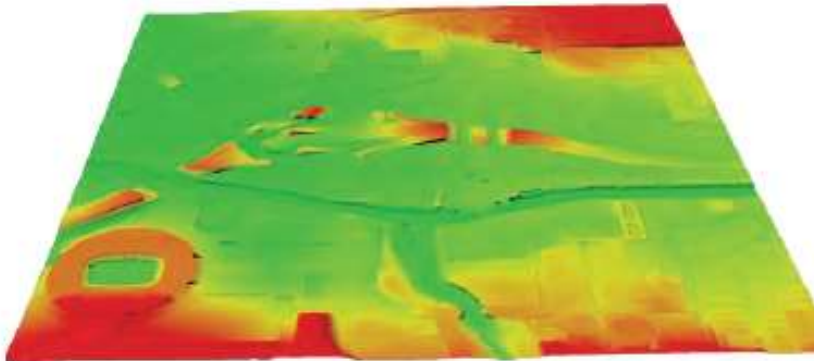
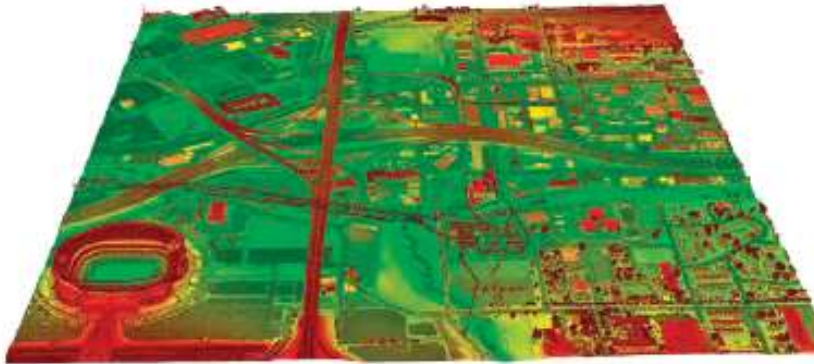
Aviation Safety

3DEP For America's Infrastructure

The significant challenge of improving the Nation's infrastructure depends on high-quality elevation data

Uses include:

- Route, grade, line-of-sight, and utility surveys and corridor mapping
- Terrain and other obstruction identification for aviation
- Dam, levee, and coastal-structure failure modeling and mitigation
- Hydraulic and hydrologic modeling
- Evaluations of geologic, coastal, and other natural hazards, and geotechnical evaluations
- Permit application and construction plan development and evaluation
- Drainage issues and cut-and-fill estimate requirements
- Vegetation, topographic, and geomorphologic feature analysis
- As-built model development
- Preliminary engineering, estimate development, and quantity estimation activities
- Bridge site selection
- Base-map and elevation model creation



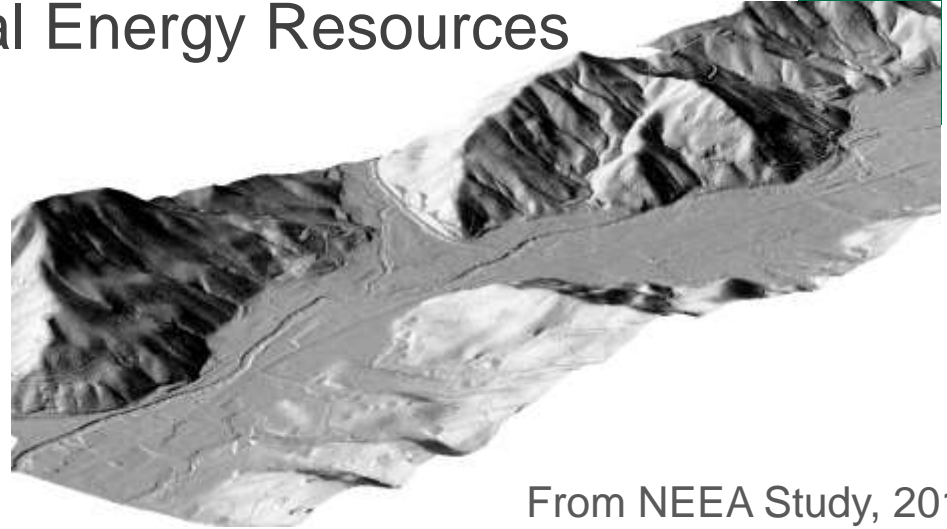
Lidar point cloud (top) and a derived bare-earth digital elevation model (bottom) for Denver, CO

Powering Our Future

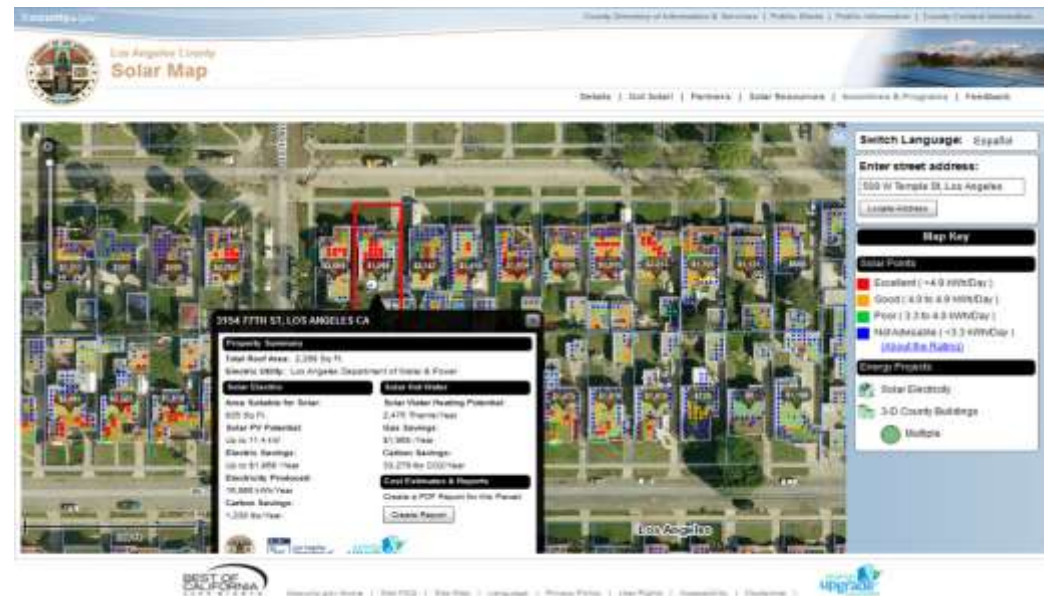
Alternative and Conventional Energy Resources

Lidar are essential for:

- Calculating wind potential
- Planning, construction and operation of hydro power
- Routing transmission lines and pipelines, construction planning, encroachment control, and asset inventories
- Determining solar potential - lidar provides roof pitch/aspect, etc.



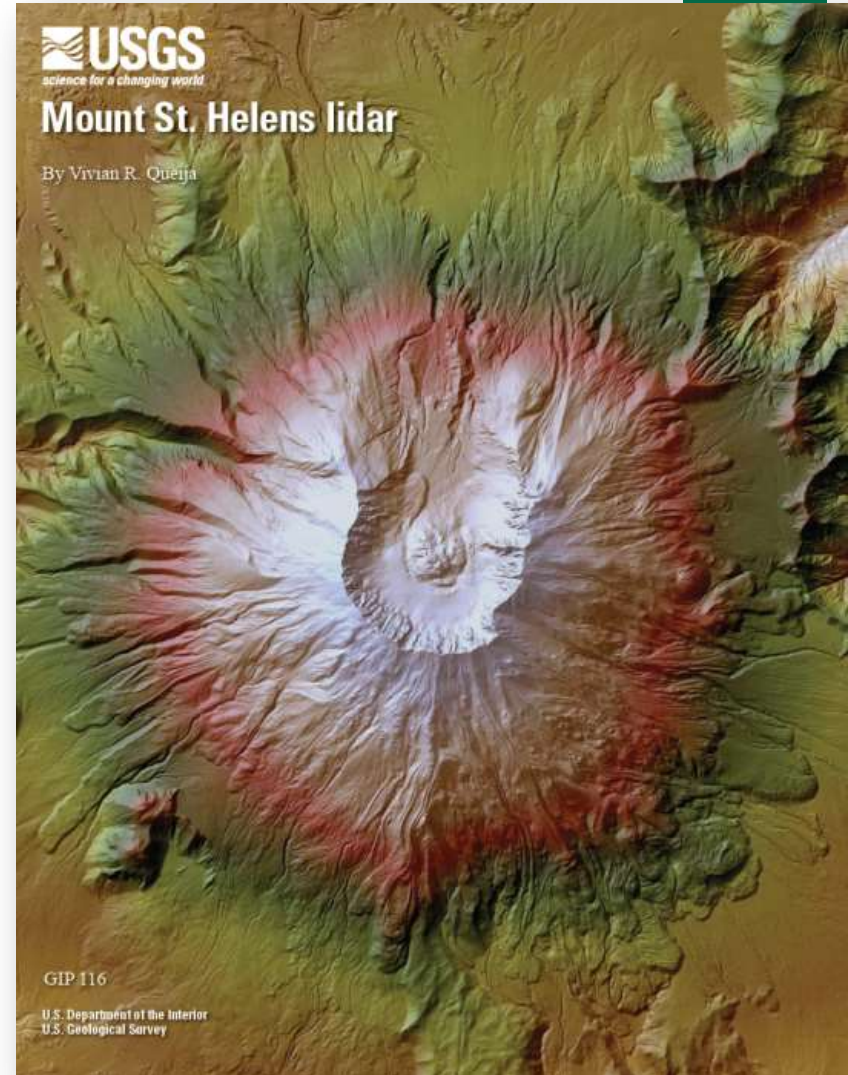
From NEEA Study, 2011



Geologic Mapping

Lidar Applications

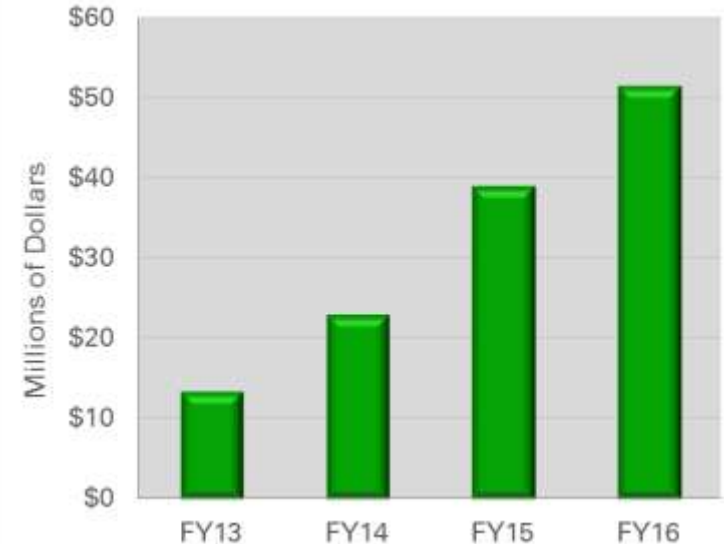
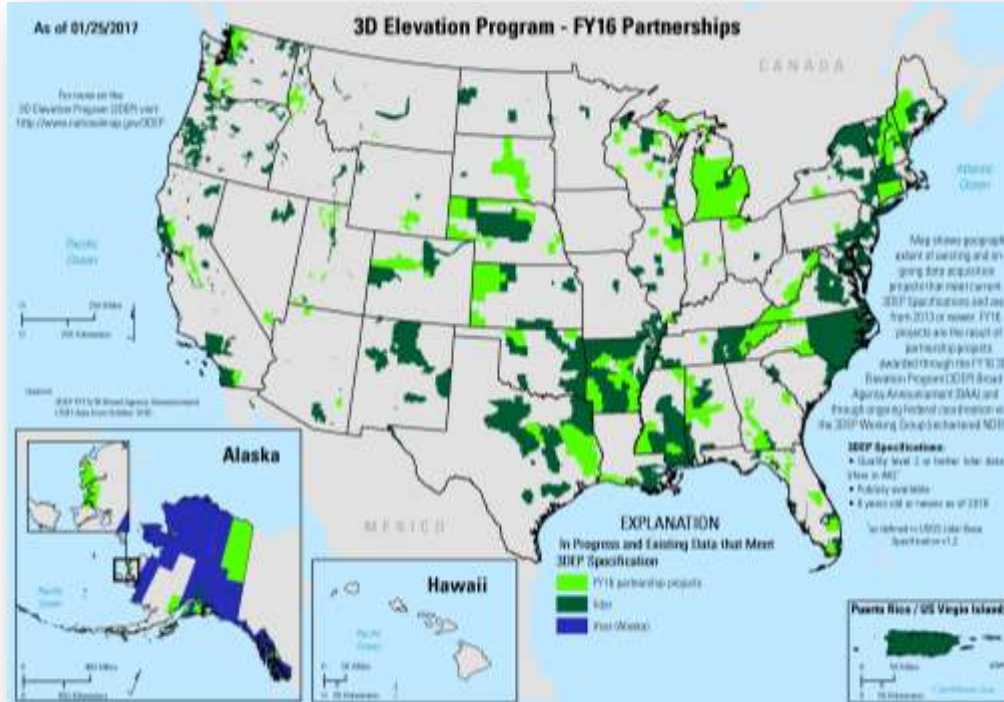
- Higher spatial resolution base maps
- Better demarcation of geological features
 - Surficial geomorphology
 - Bedrock outcrops
 - Structural feature (e.g. Faults)
 - Previously undetected subtle features like debris flows or end moraines



3DEP Growth

Strong coordination and increasing investments (FY13-16)

Map shows lidar from FY13 – FY16



3DEP Lidar Data Acquisition Funding (QL2 or better, all partners)

- 6.7% of the lower 49 and territories was acquired in FY16 - 32% increase in investment and 43% increase in square miles acquired over FY15 level
- 3DEP data have been contracted for 26% of the entire US (lidar between FY13-16 and IfSAR between FY10-16)

+ FY17 Broad Agency Announcement

Status (03/01/17)

■ Summary of proposals

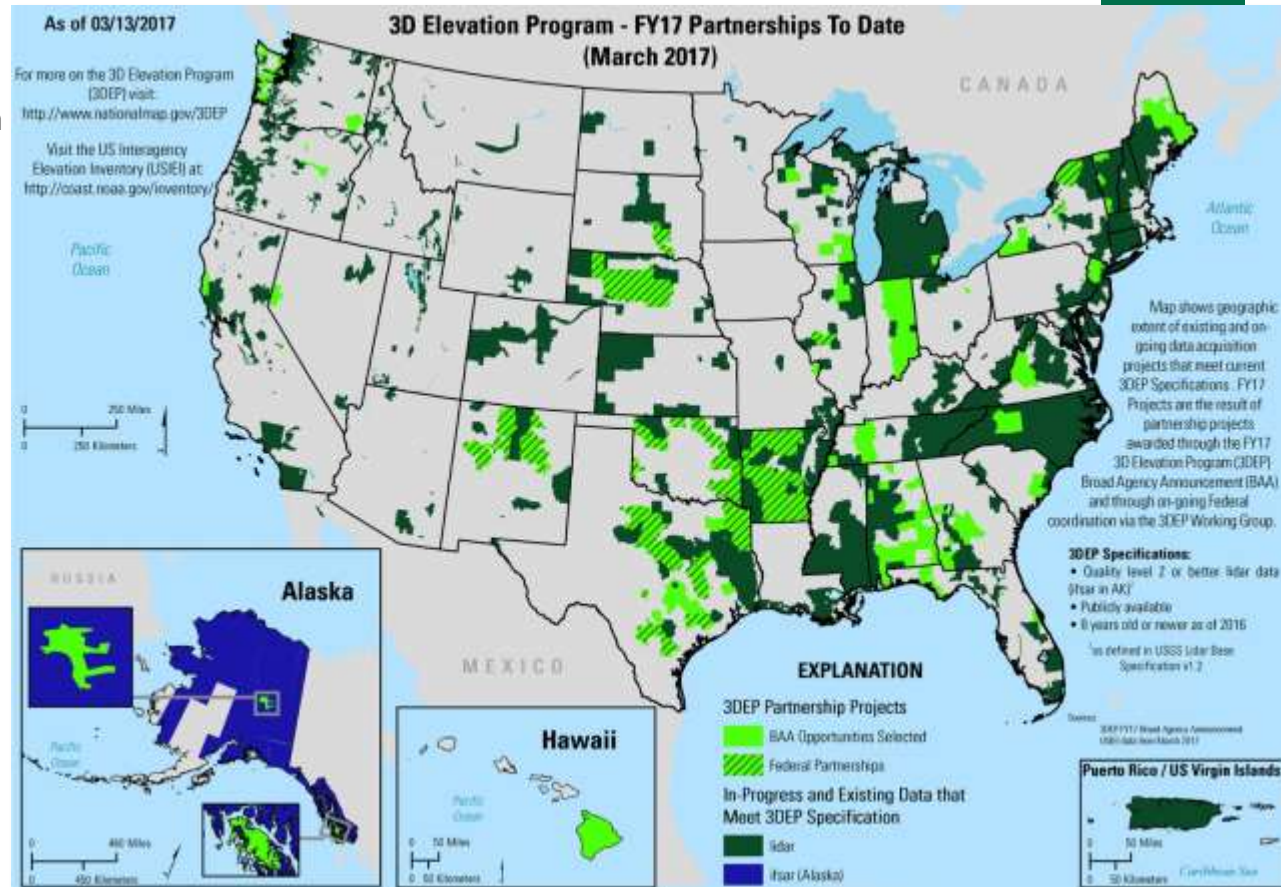
- 41 proposals in 25 states
- Total value of \$36.2 M: offering \$22.5M and seeking \$13.7 M from 3DEP
- ~155,000 sq. mi.

■ Awards to date

- 33 Projects in 25 States
- Total Value \$29M
 - Federal \$17.2M:
 - USGS \$7.6M
 - NRCS \$6.7M
 - FEMA \$1M
 - Other Feds \$1.9
 - Non-Federal \$11.8M
- ~125,000 sq. mi.

- Reaching new partners – 20 new and 13 repeat partners

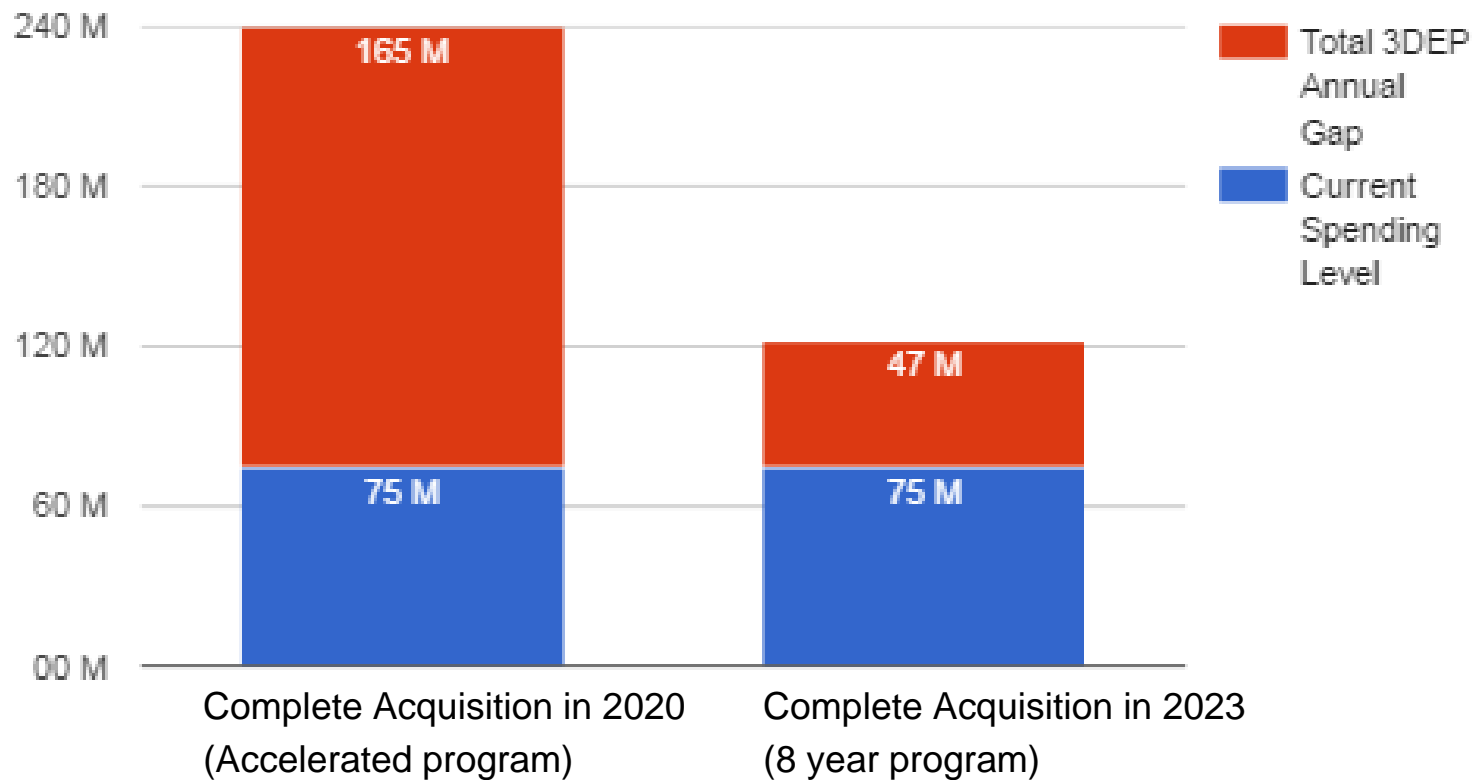
- Additional Federal investments - \$25.7M and ~121,000 sq. mi





3DEP Funding

Rough Estimate of Gap Across All Partners/Total Program Includes Alaska IfSAR and Operations (Quality Assurance and Delivery)

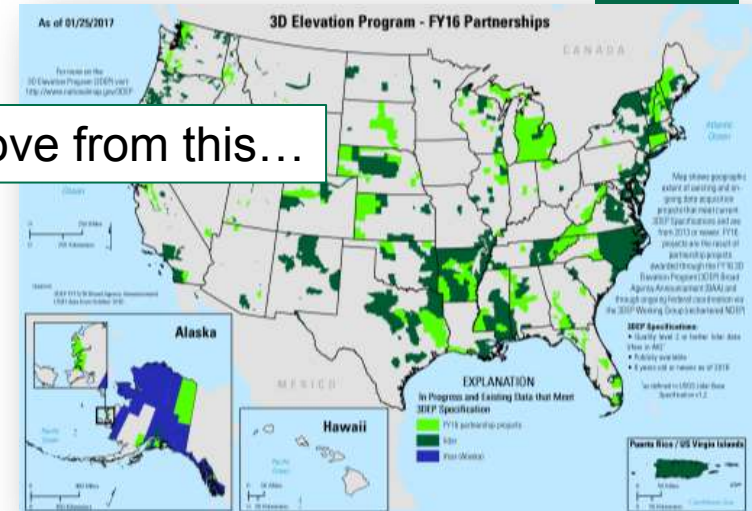


+ 3DEP National Multiyear Plan

Background

- 3DEP Executive Forum tasked the 3DEP Working Group to develop plan to:
 - Move from an annual, opportunistic process to a unified multi-year plan
 - Move from patchwork irregular acquisition footprints to a defined planning and delivery unit
 - Implement a phased approach beginning in FY18
- Benefits
 - Facilitate greater investments and leveraging through longer planning lead times
 - Defined units facilitate planning and understanding costs, allow for improved reporting and justification of investments
 - Presents a plan for nationwide coverage

Move from this...



...to something more like this



+USGS Alaska Mapping Initiative

14

The topo maps of Alaska are 50+ years old – do not meet modern accuracy standards, scales



Management of Alaska's resources is critical to Americans.



Energy production, mineral extraction, and aviation safety are in need of modern mapping.

By end of 2016, 33% of AK will have new topo maps

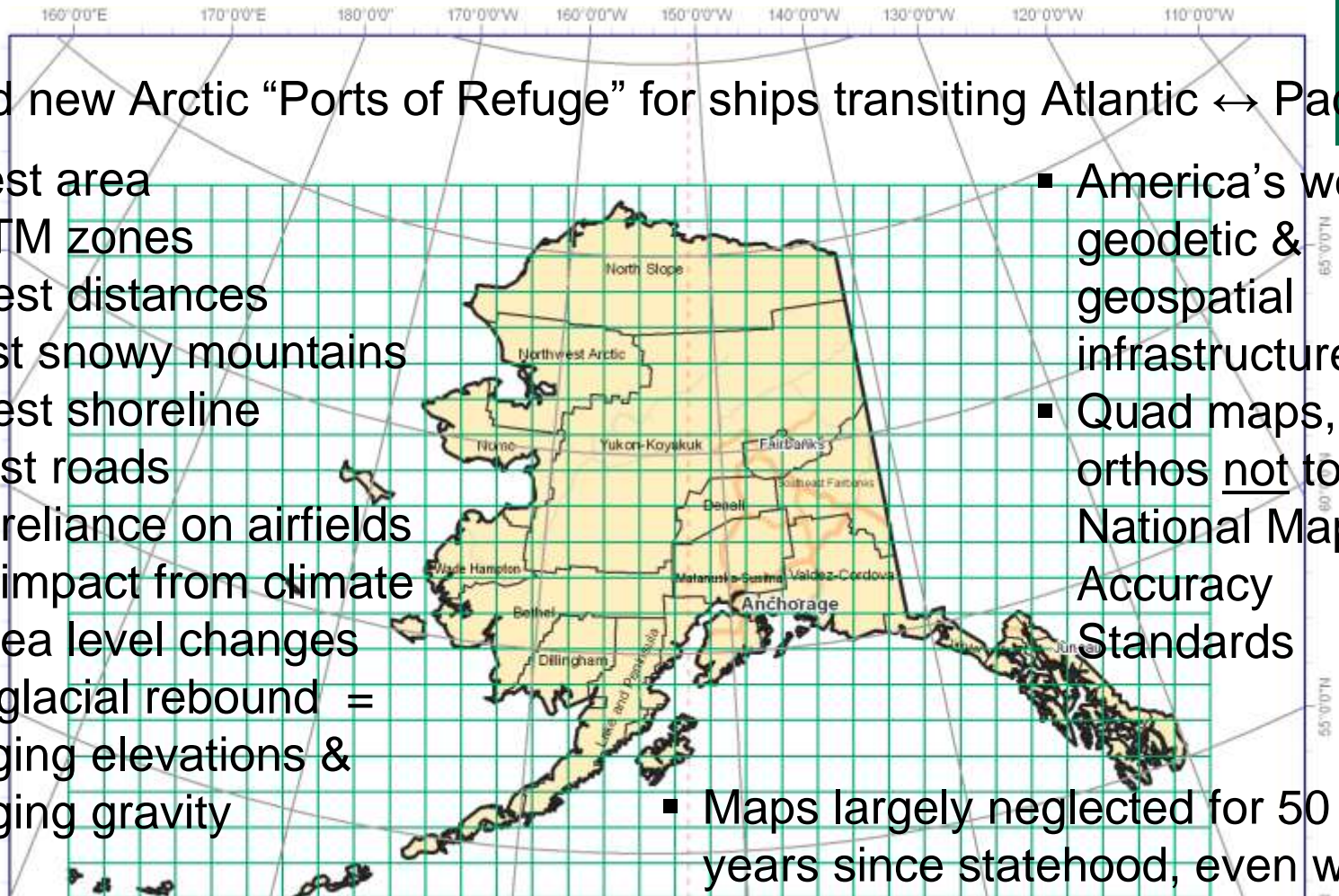


+ Why Alaska is Different and Changing

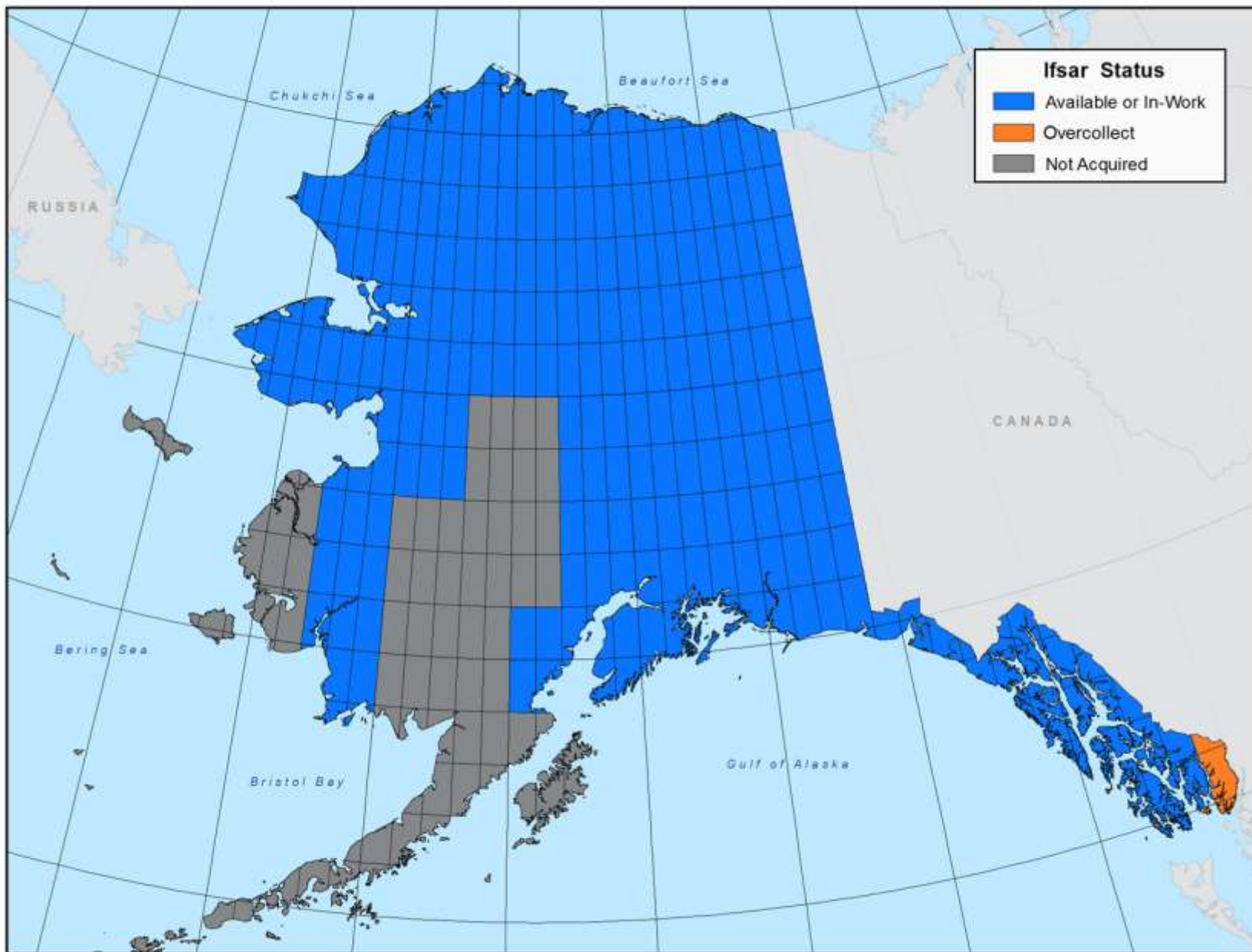
15

Need new Arctic “Ports of Refuge” for ships transiting Atlantic ↔ Pacific

- Largest area
- 10 UTM zones
- Longest distances
- Tallest snowy mountains
- Longest shoreline
- Fewest roads
- Most reliance on airfields
- Most impact from climate and sea level changes
- Post-glacial rebound = changing elevations & changing gravity
- America’s worst geodetic & geospatial infrastructure
- Quad maps, NED, orthos not to National Map Accuracy Standards
- Maps largely neglected for 50 years since statehood, even with vital natural resources



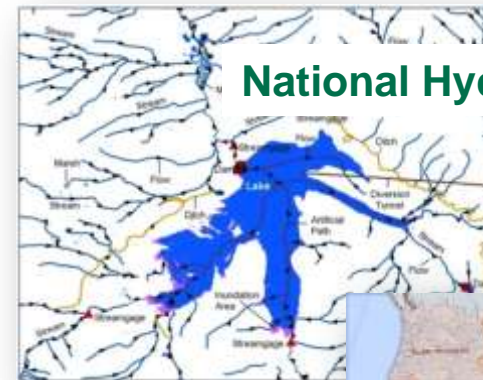
Alaska IfSAR Elevation Status - 77% Available or In-Work



+ Foundational Hydrography Datasets

Surface water layers of *The National Map*

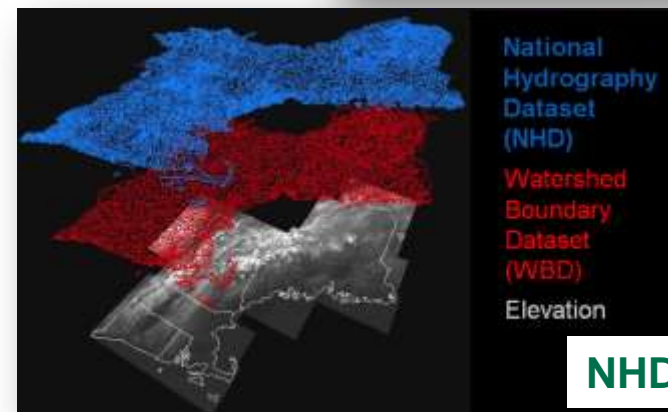
- **National Hydrography Dataset (NHD)** - the drainage network with features such as rivers, streams, canals, lakes, ponds, and stream gages
 - Allows modeling and tracing water downstream or upstream
 - Uses an addressing system based on reach codes and linear referencing to link information such as water discharge rates, water quality, and fish population
- **Watershed Boundaries Datasets (WBD)** - the drainage basins at 8 scales of a nested hierarchy; defines the areal extent of surface water drainage to a point
- **NHDPlus** - incorporates many of the best features of the NHD, WBD and elevation data to enable estimates of flow volume and velocity
 - NHD names and networking
 - Value-added attributes
 - Elevation-derived catchments for each stream segment
 - Stream and catchment attributes
 - Flow direction and accumulation grids



National Hydrography Dataset



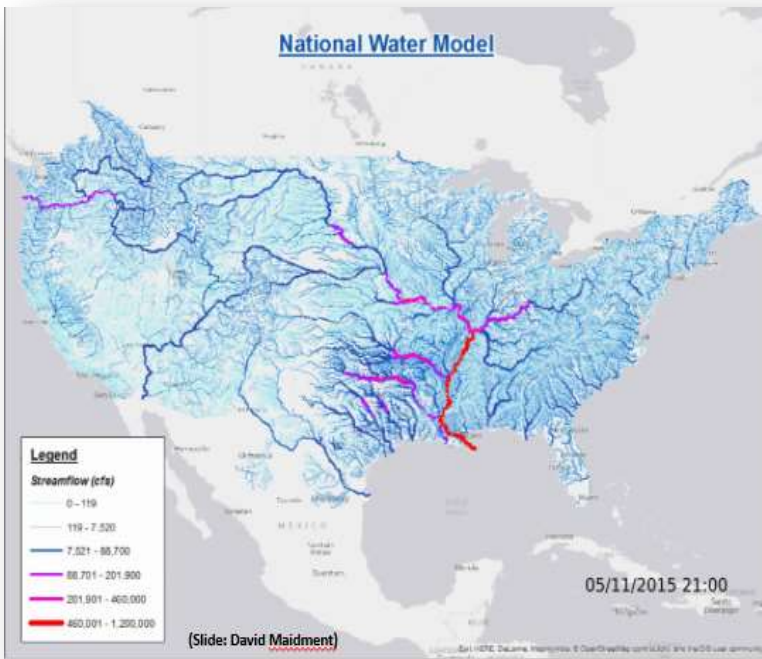
Watershed Boundaries Dataset


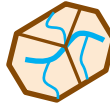



NHDPlus

+ Foundational Hydrography Datasets

Future



	IN USE TODAY: Medium Resolution NHDPlus 	IN PROGRESS: High Resolution NHDPlus 	FUTURE: Hydrography Derived from Lidar 
Number of features nationally	3 million	34.5 million	300 million
Elevation source	30 meter	10 meter	1 meter
Hydrography source	1:100,000-scale NHD	1:24,000-scale or better (local) resolution NHD	1:5,000-scale or better derived from lidar
Watershed boundaries source	Composite WBD snapshot of 2010- 2012	Updated WBD	Catchments derived from lidar

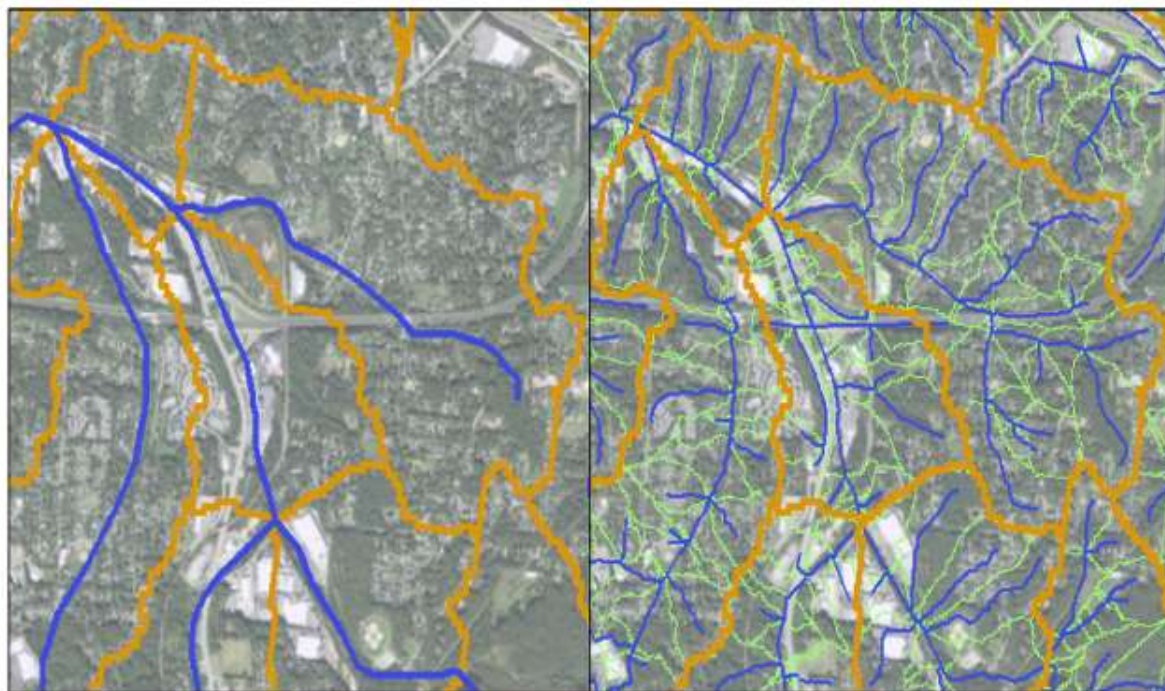
- Early analysis of the Hydrography and Benefits Study indicates that the most medium to long-term requirements will be met best by deriving hydrographic data from 3DEP data so that the elevation and hydrography are fully integrated
- Pilot projects underway to determine approaches and associated costs

+ Foundational Hydrography Datasets

19

High Resolution NHDPlus (NHD+HR)

- The Hydrography Requirements and Benefits Study and an earlier DOI study indicated that around 80% of users need the functionality of NHDPlus but at a higher resolution
- The NHD+HR composed of the highest available resolution data and generalizable to many different scales; the results will be more accurate, better maintained
- A unified, scalable geospatial framework to bring together and underpin observations and measurements
- *Target completion of beta version in FY18*

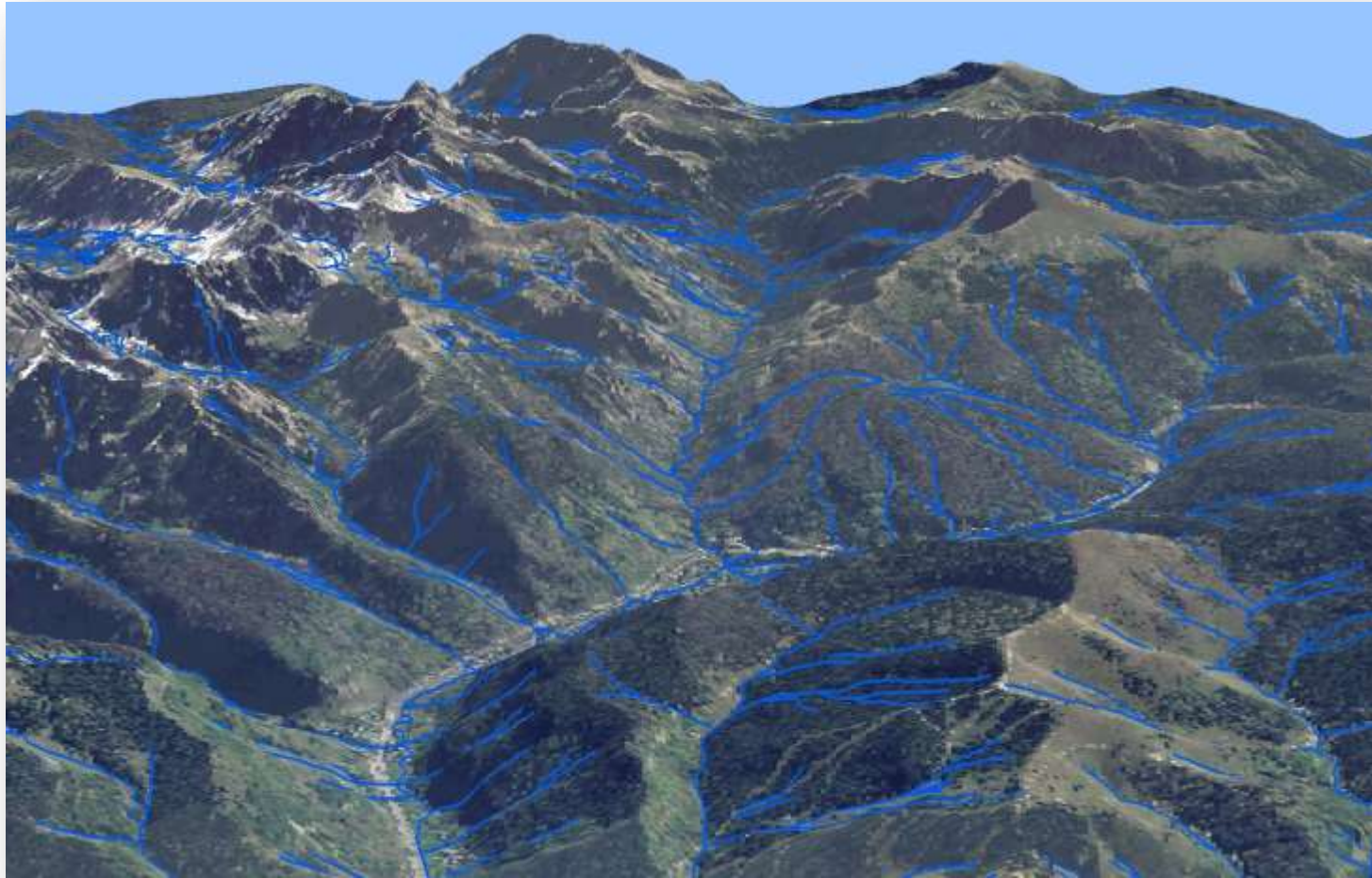


Comparison of medium (1:100,000, left) and high (1:24,000, right) resolution NHDPlus. Blue lines represent the stream network. Orange lines delineate medium-resolution catchments and green lines are catchments of the streams added at the higher resolution.



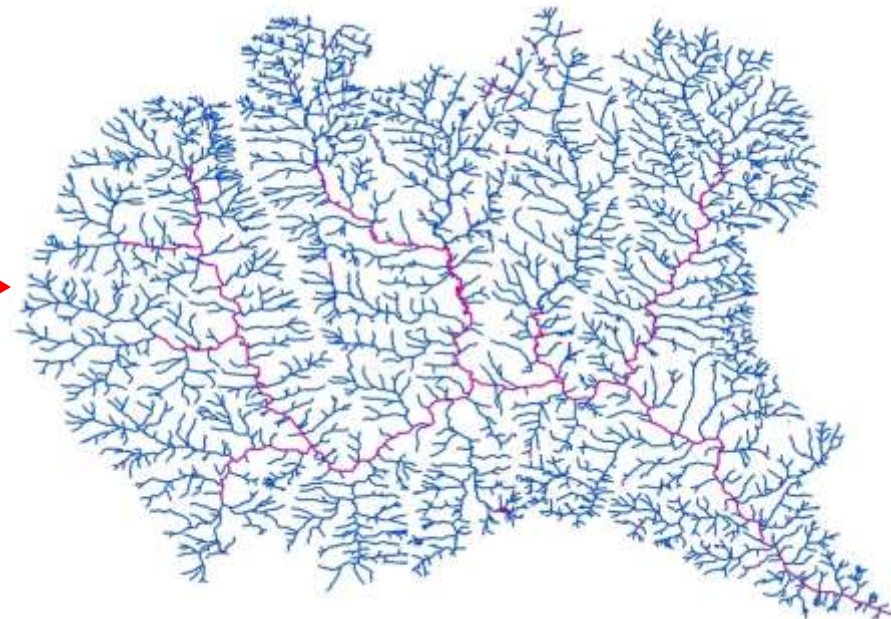
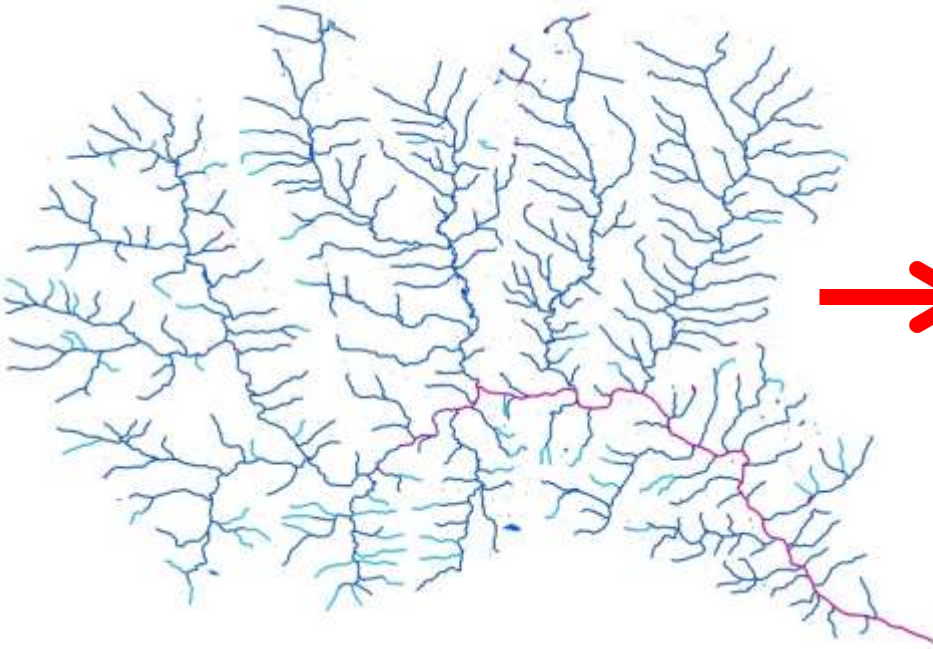
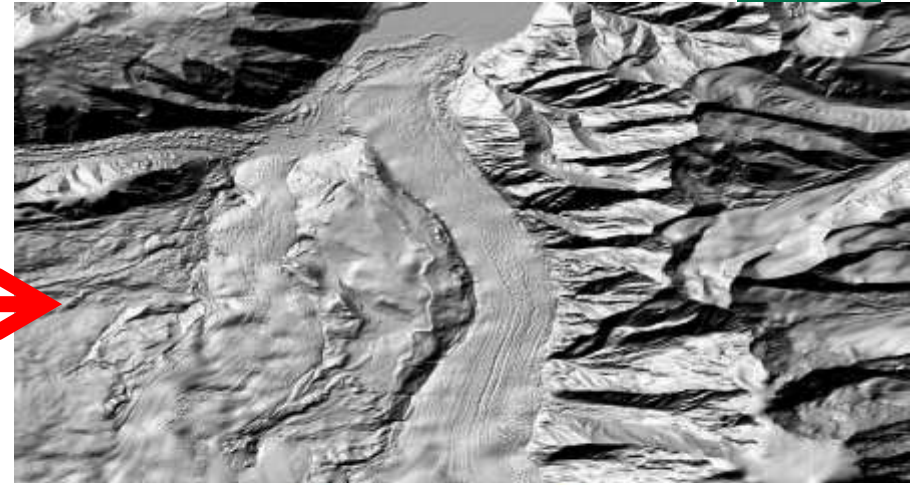
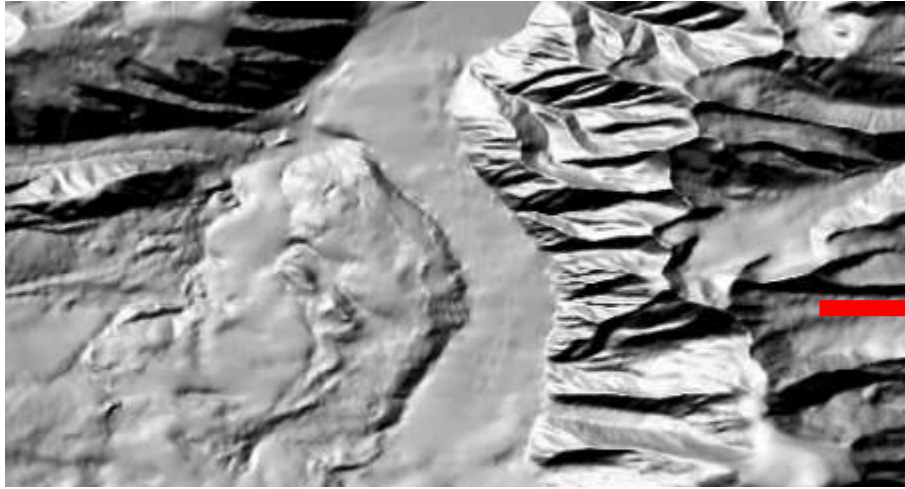
Elevation and Hydrography Are Linked

Goal to integrate datasets



+ 3D Elevation Program

Improving resolution and accuracy





Hydrography Requirements and Benefits Study (HRBS)

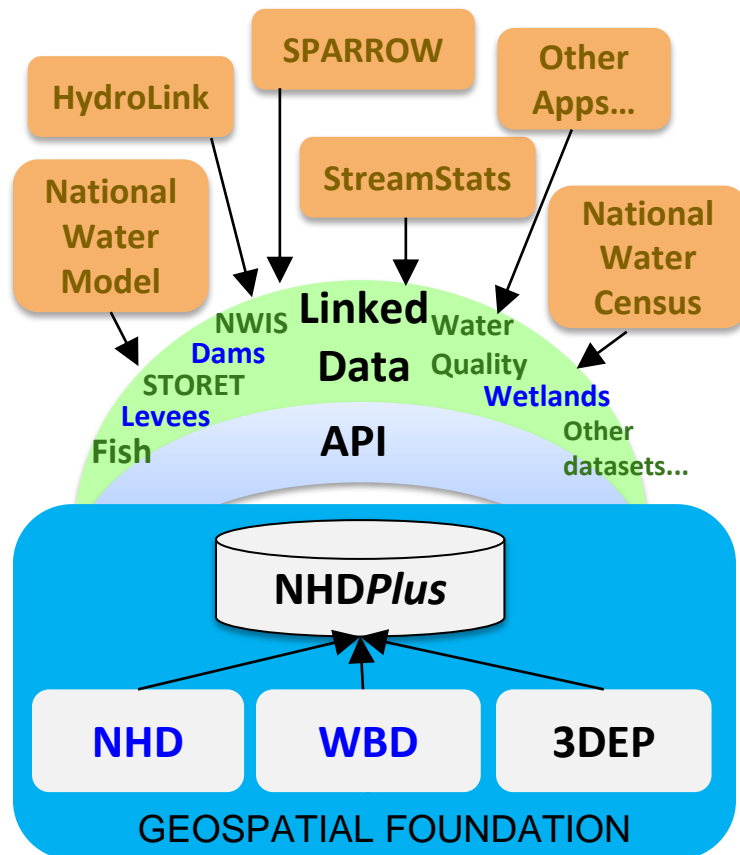
- 420 Mission Critical Activities
- 23 Federal Agencies, 50 States, 3 national associations
- Current Annual Benefits - \$538M
- Future Potential Annual Benefits - \$602M
- Benefits likely significantly under-reported - 35% of respondents were unable to provide a dollar value for future benefits.
- Program scenarios by spring, 2017



+ NHDPlus is the foundation for navigating the Nation's Water Information

NHDPlus is the geospatial foundation for:

- Linking all types of water related **data**
- Underpinning **systems** like the National Water Model
- Navigating the stream network to discover related data for a growing range of **applications**



EXAMPLE: THE WATER QUALITY PORTAL

Water Quality Portal data were mapped to NHDPlus to provide data discovery and navigation capabilities - users can now find more than 200 million data records about the health of water in the US collected by over 400 state, federal, tribal, and local agencies along 2.7 million stream segments represented in NHDPlus

EXAMPLE: GOLD KING MINE

In August, 2015, waste spilled from the Gold King Mine and contaminated the adjacent river with toxic heavy metals. The Governor of Colorado declared a disaster zone and the USGS was requested to provide all existing water quality records for the Animas River. Because the Water Quality Portal is linked to NHDPlus, what in 2015 took a group of experts several days of dedicated effort to assemble from multiple databases, can be done today in less than two minutes via a single link (<http://www.waterqualitydata.us/>)

+ National Topographic Maps

US Topo

24

- Modeled on standard 7.5-min quads
- Layered GeoPDF® (Geospatial PDF is coming)
- Orthoimage base
- Core feature layers
- 3-year production cycle
- Download free through store.usgs.gov, nationalmap.gov, data.gov, USGS Sciencebase
- Hardcopy fee for service order through store.usgs.gov



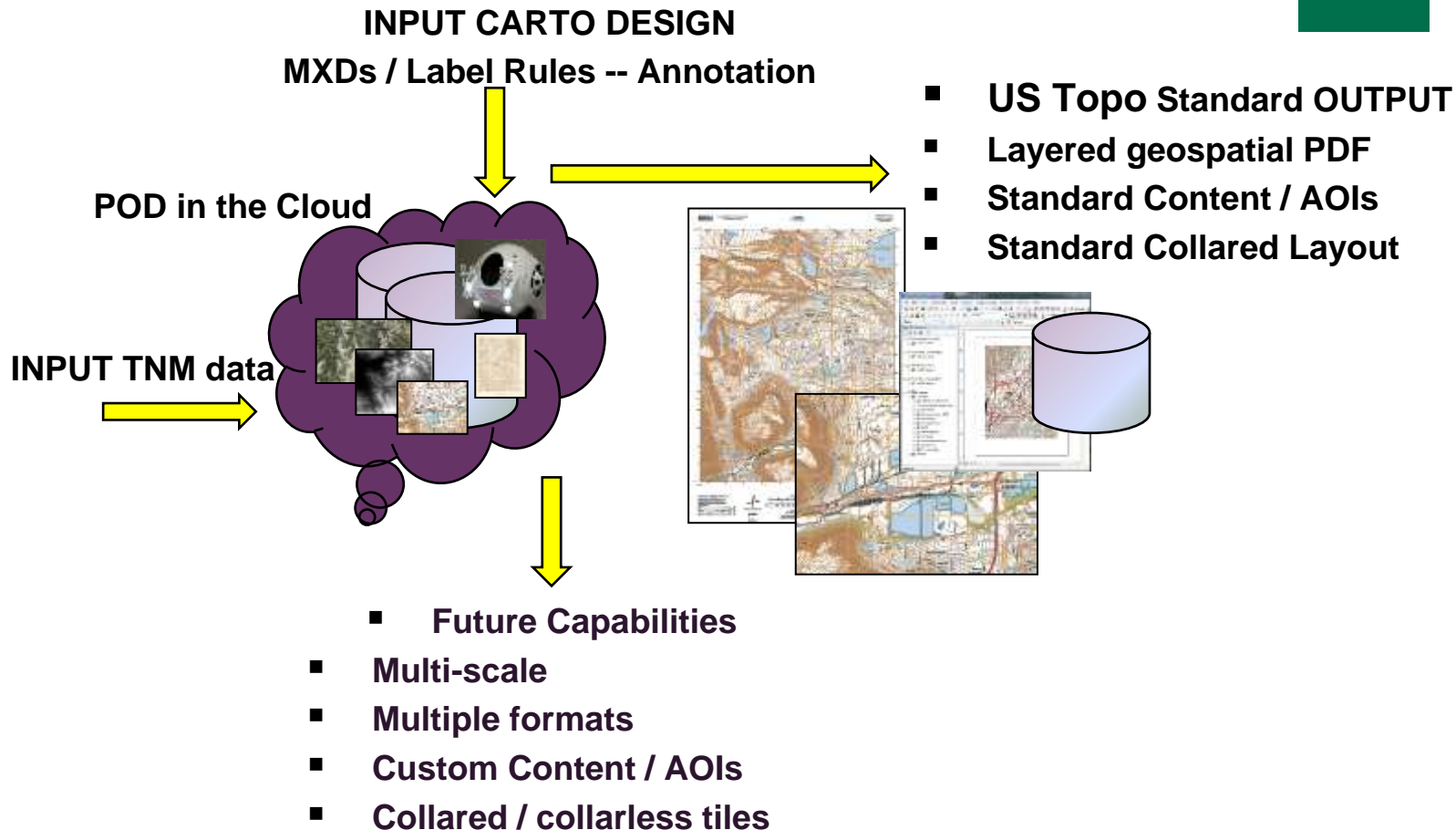
2009

Aerial Imagery
Roads
Names
Elevation Contours
Hydrography
State/County/USFS Boundaries
Runways
Woodland
Railroads
PLSS
Fire Stations
Hospitals
Schools
Military Boundaries
Cemeteries
Post Offices
Shaded Relief
Selected Trails
FWS Boundaries
State Capitals
Police Stations
Correctional Facilities
IMBA Trails
National Scenic Trails
Fish and Wildlife Service Wetlands
Updated Road network
Great Smoky Mountain Nat'l Park
Landform polygons

2016

+US Topo Product On Demand (POD)

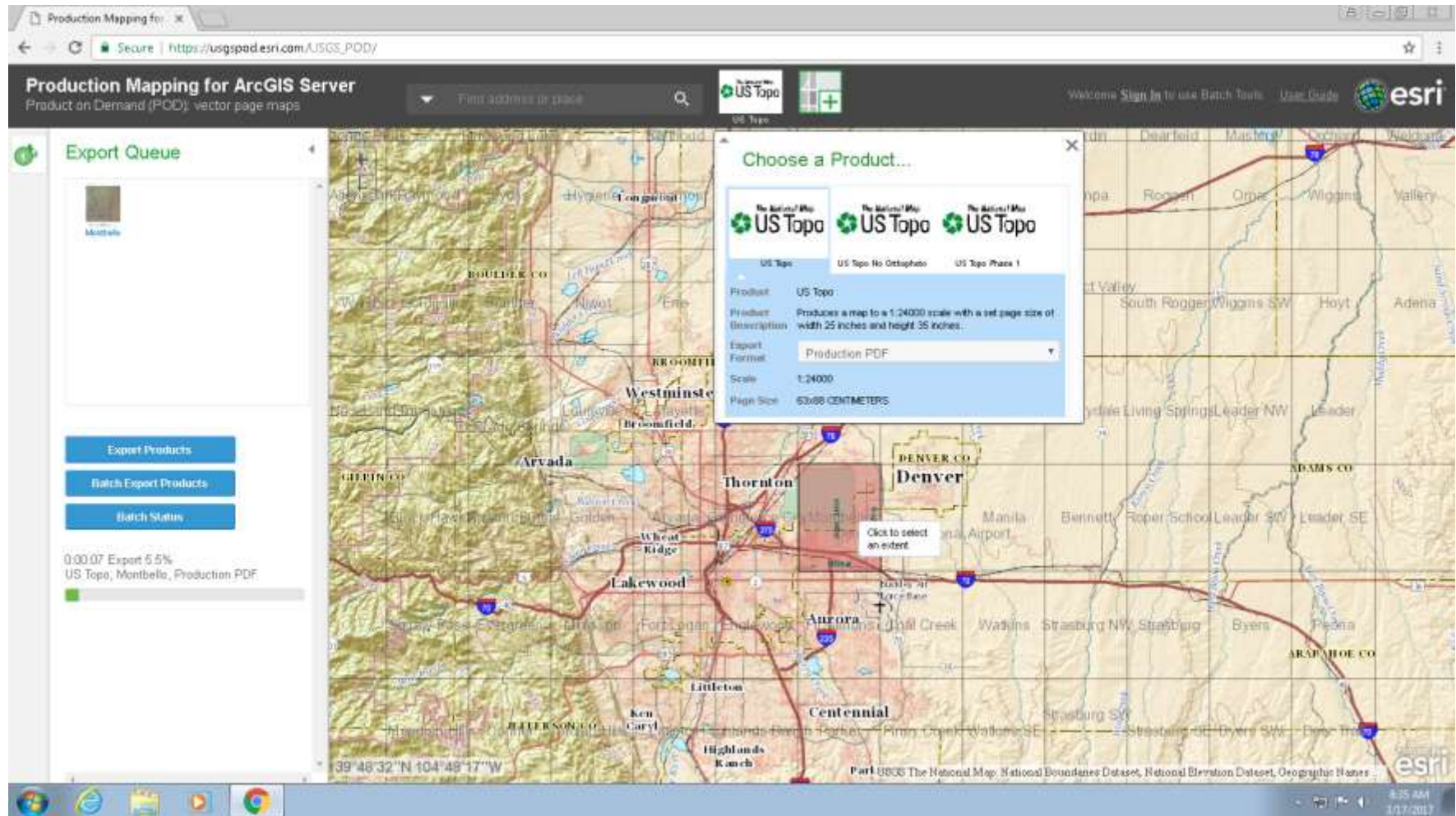
25



+Product On Demand Web Map App

26

Select AOI and Output Design; In the future, select custom data layers, additional map scales, export formats, and alternative map AOIs and page sizes



+ Mapping in the 21st Century

Changing Federal Role?

Role of Government is ... *“not to do things which individuals are doing already, and to do them a little better or a little worse; but to do those things which at present are not done at all”*

- *The Entrepreneurial State*, Mariana Mazzucato

- Role assumed by Federal Mapping Organizations in the 19th and 20th Century has changed dramatically in recent past
 - Topographic Map Compilation
 - Imagery acquisition
 - Data Collection (transportation, railways, etc)
- Federal Mapping Orgs. may need to redefine their niche in order to:
 - Avoid duplication or competition with private sector
 - Remain relevant
 - Leverage core competencies



Mapping in the 21st Century

Migrating to the Cloud

- “Private computer systems, built and operated by individual companies [and government agencies], are being supplanted by services provided over a common grid – the Internet – by centralized data-processing plants [cloud providers]. Computing is turning into a utility, and once again the economic equations that determine the way we work and live are being rewritten”

-The Big Switch, Nicholas Carr

- Cloud and distributed computing has changed how geospatial data is accessed, processed, analyzed, and visualized
- This will be a permanent shift, rather than a technology “fad”
- Federal Mapping Orgs. must adapt to this change as industry and other agencies have
 - Less (or no) reliance on internal computing architecture
 - Investments in greater and more stable networks
 - Delivery strategies that are inclusive of cloud architecture
 - Cost models that are predictable for budgets
- Not just a change in technology, but in philosophy
- Extraordinary opportunity if leveraged effectively

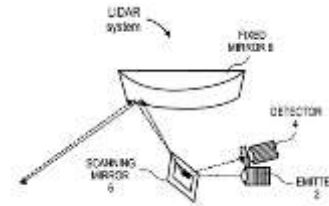


Mapping in the 21st Century

Stuff from left field

■ Big Boys

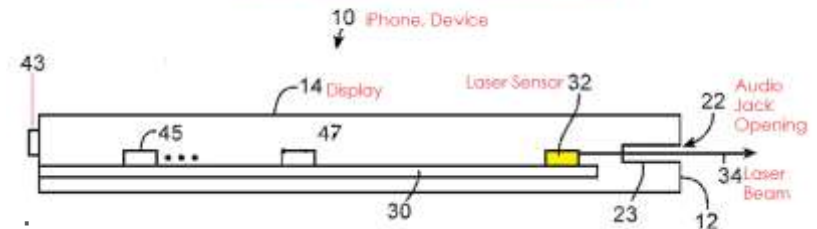
- [Apple patents a new type of LiDAR system for 3D mapping](#)
- [Apple gets patent for mobile mapping in iPhones](#)
- [LiDAR in autonomous vehicles](#)



■ Virtual Reality



FIG. 3 New Laser Beam System used in Mapping Mode



■ Machine Learning

- [Wolfram Alpha](#)
- [Google Launches Knowledge Graph To Provide Answers, Not Just Links](#)
- [Google home](#) [8:40]

■ [High Altitude Platforms](#)



Mapping in the 21st Century

- Accurate, Authoritative, Accessible, and Available geospatial data to support decision making processes that benefit society
 - Bend, shape, and propagate data to fit the needs of our users
 - Information relevance will impact NGP investments
- Mapping benefits all of society – not just one area
 - Improvements in mapping are not limited to one sector of society or industry, but are relevant to all
- Federal mapping programs are critical to a trillion dollar geoservices industry
 - Collect datasets of which others are not capable
 - Data greatly enables geoservice industry
- Scientific analysis reliant on mapping data is entering new era
 - Nationwide high-resolution datasets (elevation, hydro, imagery, etc.) combined with on-demand processing and storage permits greater scientific investigation than ever before

+ Thank you!

31

